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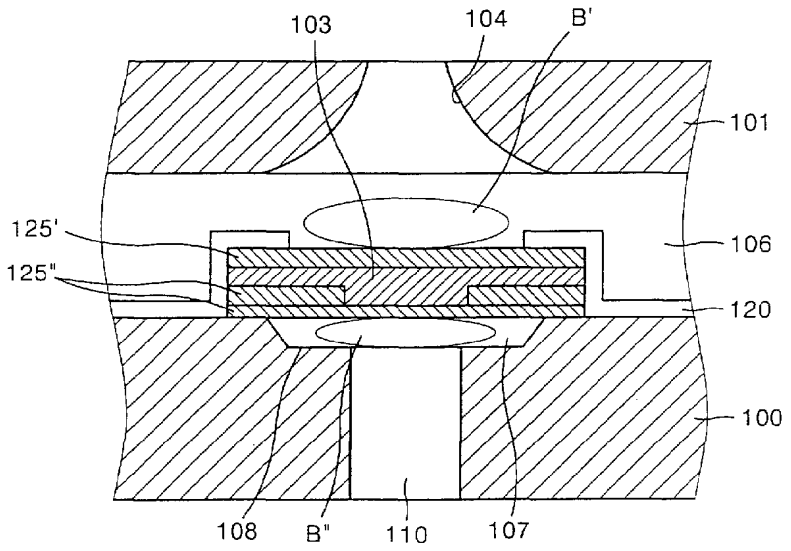
(54) Bubble-jet type ink-jet printhead

(57) A bubble-jet type ink-jet printhead is provided. The bubble-jet type ink-jet printhead includes a substrate 100, a nozzle plate 101, a wall 102, and a heater 103. The heater 103 is interposed between the substrate 100 and the nozzle plate 101 to divide an ink chamber filled with ink into a main ink chamber 106 and a secondary ink chamber 107, thereby generating a main bubble and a secondary bubble. The printhead further includes an ink channel 110 for introducing ink into the secondary ink chamber 107 and then supplying the ink to the main ink chamber 106. Accordingly, the printhead consumes less energy, prevents a backflow of ink, and operates at increased speed.

FIG. 8



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Description

[0001] The present invention relates to an ink-jet printhead, and more particularly, to a bubble-jet type ink-jet printhead.

[0002] Ink-jet printing heads are devices for printing a predetermined color image by ejecting a small droplet of printing ink at a desired position on a recording sheet. Ink ejection mechanisms of an ink-jet printer are largely categorized into two types: an electro-thermal transducer type (bubble-jet type) in which a heat source is employed to form a bubble in ink causing ink droplets to be ejected, and an electro-mechanical transducer type in which a piezoelectric crystal bends to change the volume of ink causing ink droplets to be expelled.

[0003] Referring to FIGS. 1A and 1B, a typical bubble-jet type ink ejection mechanism will now be described. When a current pulse is applied to a heater 12 consisting of resistive heating elements formed in an ink channel 10 where a nozzle 11 is located, heat generated by the heater 12 boils ink 14 to form a bubble 15 within the ink channel 10, which causes an ink droplet 14' to be ejected.

[0004] Meanwhile, an ink-jet printhead having this bubble-jet type ink ejector needs to meet the following conditions. First, it must have a simplified manufacturing process and a low manufacturing cost, and high volume production must be feasible. Second, to produce high quality color images, creation of minute satellite droplets that trail ejected main droplets must be prevented. Third, when ink is ejected from one nozzle or ink refills an ink chamber after ink ejection, cross-talk with adjacent nozzles from which no ink is ejected must be prevented. To this end, a back flow of ink in the opposite direction of a nozzle must be avoided during ink ejection. A second heater 13 in FIGS. 1A and 1 B is provided to prevent a back flow of the ink 14. The second heater 13 generates heat sooner than the first heater 12, which causes a bubble 16 to shut off the ink channel 10 behind the first heater 12. Then, the first heater 12 generates heat and the bubble 15 expands to cause the ink droplet 14' to be ejected. Fourth, for high speed printing, a cycle beginning with ink ejection and ending with ink refill must be as short as possible. Fifth, a nozzle and an ink channel for introducing ink into the nozzle must not be clogged by foreign material or solidified ink.

[0005] However, the above conditions tend to conflict with one another, and furthermore, the performance of an ink-jet printhead is closely associated with structures of an ink chamber, an ink channel, and a heater, the type of formation and expansion of bubbles, and the relative size of each component.

[0006] FIG. 2 is a perspective view showing the internal structure of a conventional ink-jet printhead, and FIG. 3 is a cross-section for explaining the ejection of an ink droplet in the printhead of FIG. 2. Referring to FIG. 2, the ink-jet printhead includes a substrate 20, a wall 22 formed on the substrate 20 for providing an ink chamber 26 for containing ink, a heater 23 disposed in the ink chamber 26 for generating heat, and a nozzle plate 21 having an orifice 24 for ejecting an ink droplet. Ink is supplied to the ink chamber 26 through an ink channel 25 and to the orifice 24 connected to the ink chamber 26 by capillary action.

[0007] Referring to FIG. 3, in this configuration, if current is applied to the heater 23, the heater 23 generates heat to form a bubble B in ink filling the ink chamber 26 as shown in FIG. 3. Then, the bubble B expands to exert pressure on the ink within the ink chamber 26 causing an ink droplet 28 to be ejected through the orifice 24.

[0008] However, in the ink-jet printhead having the structure described above, a considerable amount of heat generated by the heater 23 is transferred and absorbed into the substrate 20. That is, it is desirable that the heat generated by the heater 23 be used to boil ink and form the bubble B. However, most of the heat is actually absorbed into the substrate 20, and only a small amount is used to form the bubble B. This means that the heat energy supplied to generate the bubble B is wasted in heating the substrate 20, thereby increasing energy consumption. Also, the ink-jet printhead has a problem in that the temperature of a head is significantly increased as a print cycle runs because the heat transferred to the substrate 20 in turn heats the head system. Furthermore, the heat flows into the substrate 20 to heat or cool ink at low speed, thereby increasing the length of the cycle from the formation to the collapse of the bubble and thus decreasing print speed.

[0009] Typically, the amount of ink pushed away from a nozzle by a generated bubble is closely related to the print speed of an ink-jet printhead. In the ink-jet printhead having the structure described above, the amount of ink which is approximately the same as that ejected by the bubble B is pushed away from the orifice 24, thereby making a print cycle longer and thus reducing the print speed of the printhead.

[0010] According to a first aspect of the invention there is provided a bubble-jet type ink-jet printhead including: a substrate; a nozzle plate separated from the substrate by a predetermined distance, the nozzle plate having an orifice for ejecting ink; a wall for closing the space between the substrate and the nozzle plate and forming an ink chamber filled with ink therebetween; and a heater interposed between the substrate and the nozzle plate for dividing the ink chamber into a main ink chamber disposed above the heater and a secondary ink chamber disposed below the heater and boiling ink filling the main ink chamber and the secondary ink chamber in order to generate a main bubble and a secondary bubble, respectively.

[0011] The present invention may thus provide a bubble-jet type ink-jet printhead configured so that a heater disposed within an ink chamber does not directly contact a substrate and an ink channel is disposed inside the substrate thereby consuming less energy in operating the printhead, preventing a backflow of ink, and increas-

ing the printing speed of the printhead.

[0012] Preferably, a groove for forming the secondary ink chamber is formed in the substrate corresponding to the heater. The main ink chamber and the secondary ink chamber are connected to each other.

[0013] In another aspect, a bubble-jet type ink-jet printhead includes: a substrate; a nozzle plate separated from the substrate by a predetermined distance, the nozzle plate having an orifice for ejecting ink; a wall for closing the space between the substrate and the nozzle plate and forming an ink chamber filled with ink therebetween; a heater interposed between the substrate and the nozzle plate for dividing the ink chamber into a main ink chamber disposed above the heater and a secondary ink chamber disposed below the heater and boiling ink filling the main ink chamber and the secondary ink chamber in order to generate a main bubble and a secondary bubble, respectively; and an ink channel connecting the secondary ink chamber to an ink reservoir so that ink is introduced into the secondary ink chamber and then supplied to the main ink chamber.

[0014] Preferably, a groove for forming the secondary ink chamber is formed in the substrate corresponding to the heater. The ink channel is formed corresponding to the central portion of the heater by penetrating the bottom of the secondary ink chamber. Upper and lower passivation layers are formed above and below the heater, respectively. A portion of the lower passivation layer corresponding to the ink channel is thinner than the upper passivation layer.

[0015] The above object and advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

FIGS. 1A and 1B are cross-sections for explaining the ink ejection mechanism of a conventional bubble-jet type ink-jet printhead;

FIG. 2 is a perspective view showing the internal structure of a conventional ink-jet printhead;

FIG. 3 is a cross-section for explaining the ejection of an ink droplet in the printhead of FIG. 1;

FIG. 4 is a cross-section of a bubble-jet type ink-jet printhead according to an embodiment of the present invention;

FIG. 5 is a plan view showing the inside of the printhead of FIG. 4;

FIG. 6 is a cross-section of a bubble-jet type ink-jet printhead according to another embodiment of the present invention;

FIG. 7 is a plan view showing the inside of the printhead of FIG. 6; and

FIG. 8 is a cross-section of a heater portion in which passivation layers of different thicknesses are disposed.

[0016] Referring to FIGS. 4 and 5, a bubble-jet type ink-jet printhead according to a first embodiment of the present invention includes a substrate 100, a nozzle plate 101 separated from the substrate 100 by a predetermined distance, a wall for forming an ink chamber to be filled with ink between the substrate 100 and the nozzle plate 101, and a heater 103 disposed in the ink chamber for generating heat. An orifice 104 for ejecting ink is formed in the nozzle plate 101, and ink is supplied to the ink chamber from an ink reservoir (not shown) through an ink channel 105. A rectangular groove 108 is formed in the substrate 100 at a position opposite the orifice 104, and the heater 103 is disposed on a portion of the substrate 100 where the rectangular groove 108 is formed. Thus, the ink chamber is divided into a main ink chamber 106 disposed above the heater 103 and a secondary ink chamber 107 disposed below the heater 103 or within the groove 108 on the substrate 100. As shown in FIG. 5, the heater 103 is formed on the portion of the substrate 100 where the groove 108 is formed, and the main ink chamber 106 is connected to the inside of the secondary ink chamber 107 so that the heater 103 is surrounded by ink filling the ink chambers 106 and 107. In this case, to prevent the ink within the ink chambers 106 and 107 from contacting the heater 103, passivation layers 125 are formed on the top and bottom of the heater 103, respectively. To heat the heater 103 by applying current, the heater 103 is connected to a conductor 120 through a through hole (not shown) formed in the passivation layer 125.

[0017] In this configuration, if current is supplied to the heater 103 through the conductor 120, the heater 103 generates heat to form a main bubble B' and a secondary bubble B" in the ink contained in the main ink chamber 106 and the secondary ink chamber 107, respectively. The bubbles B' and B" expand to cause the ink to be ejected through the orifice 104 formed in the nozzle plate 101.

[0018] Thus, unlike the conventional art, the heater 103 is surrounded by the ink within the main ink chamber 106 and the secondary ink chamber 107, thereby transferring all of the heat generated by the heater 103 to the ink and thus generating the bubbles B' and B".

[0019] Although the embodiment has been described with respect to the rectangular groove 108, other shapes of the groove 108 are available when the secondary ink chamber 107 formed in the groove 108 operates as described above.

[0020] FIGS. 6 and 7 show a bubble-jet type ink-jet printhead according to a second embodiment of the present invention. FIG. 6 is a cross-section of the ink-jet printhead according to this embodiment, and FIG. 7 is a plan view showing the inside of the printhead of FIG. 6. Here, the same reference numerals as shown in FIGS. 4 and 5 denote the same members.

[0021] Referring to FIGS. 6 and 7, the bubble-jet type ink-jet printhead according to the second embodiment of the present invention includes a substrate 100, a nozzle plate 101, a wall 102, and a heater 103. Passivation layers 125 are formed on the top and bottom of the heat-

er 103, respectively, and a conductor 120 for applying current is connected to the heater 103. A rectangular groove 108 is formed in the substrate 100 opposite an orifice 104, and the heater 103 is disposed on the groove 108. A main ink chamber 106 and a secondary ink chamber 107 are formed above and below the heater 103, respectively, and both ink chambers 106 and 107 are connected to each other as shown in FIG. 7. An ink channel 110 for introducing ink from an ink reservoir (not shown) into the secondary ink chamber 107 and then supplying the ink to the main ink chamber 106 is formed corresponding to the central part of the substrate 103 by penetrating the bottom of the secondary ink chamber 107.

[0022] In this configuration, all of the heat generated by the heater 103 is transferred to ink, thus generating a main bubble B' and a secondary bubble B" as described above. During ink ejection, the secondary bubble B" generated in the secondary ink chamber 107 blocks an inlet of the ink channel 110 penetrating the bottom of the secondary ink chamber 107, thereby preventing a backflow of ink. To effectively prevent a backflow of ink, the shape or depth of the groove 108 forming the secondary ink chamber and the cross-section of the ink channel 110 need to be considered.

[0023] As described above, although this embodiment has been described with respect to the rectangular groove 108, other shapes of the groove 108 are available.

[0024] In order to more effectively prevent a backflow of ink, passivation layers disposed at a main ink chamber side and a secondary ink chamber side of the heater 103 for insulation between ink and the heater 103 may have different thicknesses, and the passivation layer at the secondary ink chamber side is a multilayer. FIG. 8 is a cross-section of a heater portion in which passivation layers of different thicknesses are disposed.

[0025] Referring to FIG. 8, a portion of a lower passivation layer 125" disposed below the heater 103 corresponding to the ink channel 110 is thinner than an upper passivation layer 125' disposed above the heater 103. Thus, heat generated by the heater 103 is transferred to ink filling the secondary ink chamber 107 faster than to that filling the main ink chamber 106, thereby generating the secondary bubble B" sooner than the main bubble B'. This effectively blocks the pressure generated by the main bubble B' and consequently prevents a backflow of ink. Furthermore, the printhead is configured so that the lower passivation layer 125" is a multilayer and only the portion of the lower passivation layer 125" corresponding to the ink channel 110 is made thinner, thereby reducing the size of the secondary bubble B" generated in the secondary ink chamber 107, thereby preventing a backflow of ink due to the secondary bubble B" itself while blocking the pressure from the main bubble B'.

[0026] In the above-described embodiments, the main ink chamber 106 and the secondary ink chamber 107 have been formed by disposing the heater 103 on the groove 108 formed in the substrate 100. Alternatively, a main ink chamber and a secondary ink chamber may be formed by simply interposing the heater 103 between the substrate 100 and the nozzle plate 101, with no groove 108 formed in the substrate 100.

[0027] As described above, a bubble-jet type ink-jet printhead according to the present invention is configured to have the heater 103 interposed between the substrate 100 and the nozzle plate 101, surrounded by ink, thus consuming less energy in operating the printhead by reducing heat loss from the heater 103 to the substrate 100, increasing the endurance of the printhead by reducing unnecessary heat accumulated in the substrate 100, and increasing the printing speed of the printhead due to quick cooling of the heater 103 after ink ejection. Furthermore, the ink channel 110 is provided below the heater 103, thereby preventing a backflow of ink during ink ejection and increasing the printing speed of the printhead.

[0028] While this invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

Claims

1. A bubble-jet type ink-jet printhead comprising:

   a substrate;
   a nozzle plate separated from the substrate by a predetermined distance, the nozzle plate having an orifice for ejecting ink;
   a wall for closing the space between the substrate and the nozzle plate and forming an ink chamber filled with ink therebetween; and
   a heater interposed between the substrate and the nozzle plate for dividing the ink chamber into a main ink chamber disposed above the heater and a secondary ink chamber disposed below the heater and boiling ink filling the main ink chamber and the secondary ink chamber in order to generate a main bubble and a secondary bubble, respectively.

2. The printhead of claim 1, wherein a groove for forming the secondary ink chamber is formed in the substrate corresponding to the heater.

3. The printhead of claim 1 or 2, wherein the main ink chamber and the secondary ink chamber are connected to each other.

4. A bubble-jet type ink-jet printhead comprising:

a substrate;
a nozzle plate separated from the substrate by a predetermined distance, the nozzle plate having an orifice for ejecting ink;
a wall for closing the space between the substrate and the nozzle plate and forming an ink chamber filled with ink therebetween;
a heater interposed between the substrate and the nozzle plate for dividing the ink chamber into a main ink chamber disposed above the heater and a secondary ink chamber disposed below the heater and boiling ink filling the main ink chamber and the secondary ink chamber in order to generate a main bubble and a secondary bubble, respectively; and
an ink channel connecting the secondary ink chamber to an ink reservoir so that ink is introduced into the secondary ink chamber and then supplied to the main ink chamber.

5. The printhead of claim 4, wherein a groove for forming the secondary ink chamber is formed in the substrate corresponding to the heater.

6. The printhead of claim 5, wherein the ink channel is formed corresponding to the central portion of the heater by penetrating the bottom of the secondary ink chamber.

7. The printhead of any one of claims 4-6, wherein upper and lower passivation layers are formed above and below the heater, respectively.

8. The printhead of claim 7, wherein the lower passivation layer is thinner than the upper passivation layer.

9. The printhead of claim 7, wherein a portion of the lower passivation layer corresponding to the ink channel is thinner than the upper passivation layer.

FIG. 1A (PRIOR ART)

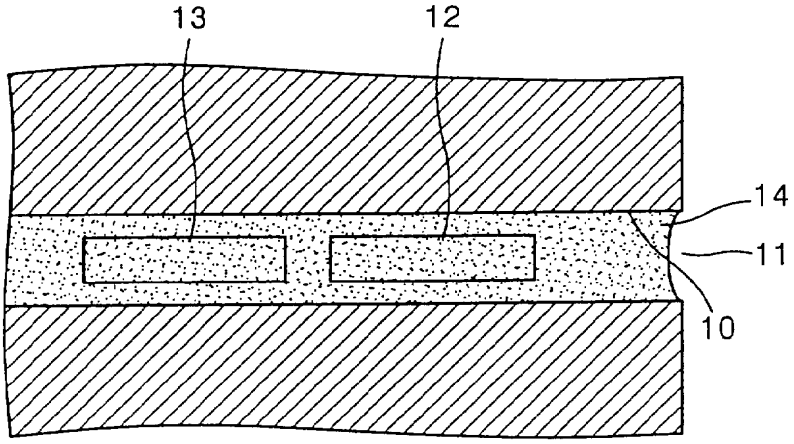

FIG. 1B (PRIOR ART)

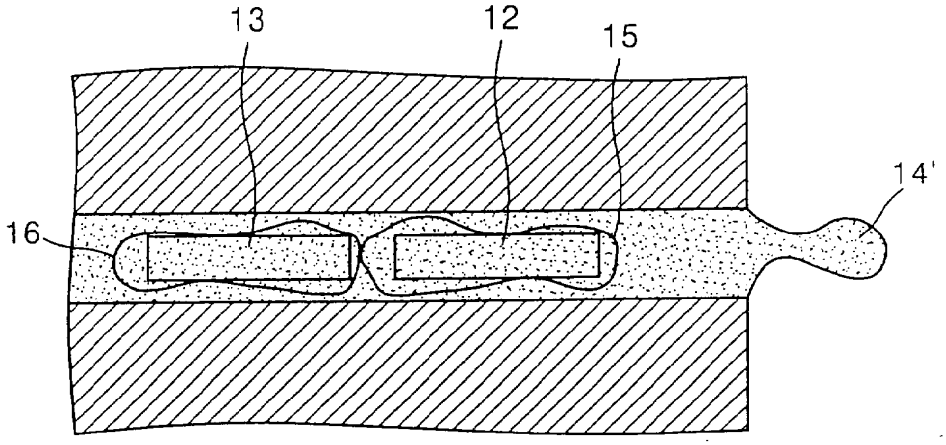

FIG. 2 (PRIOR ART)

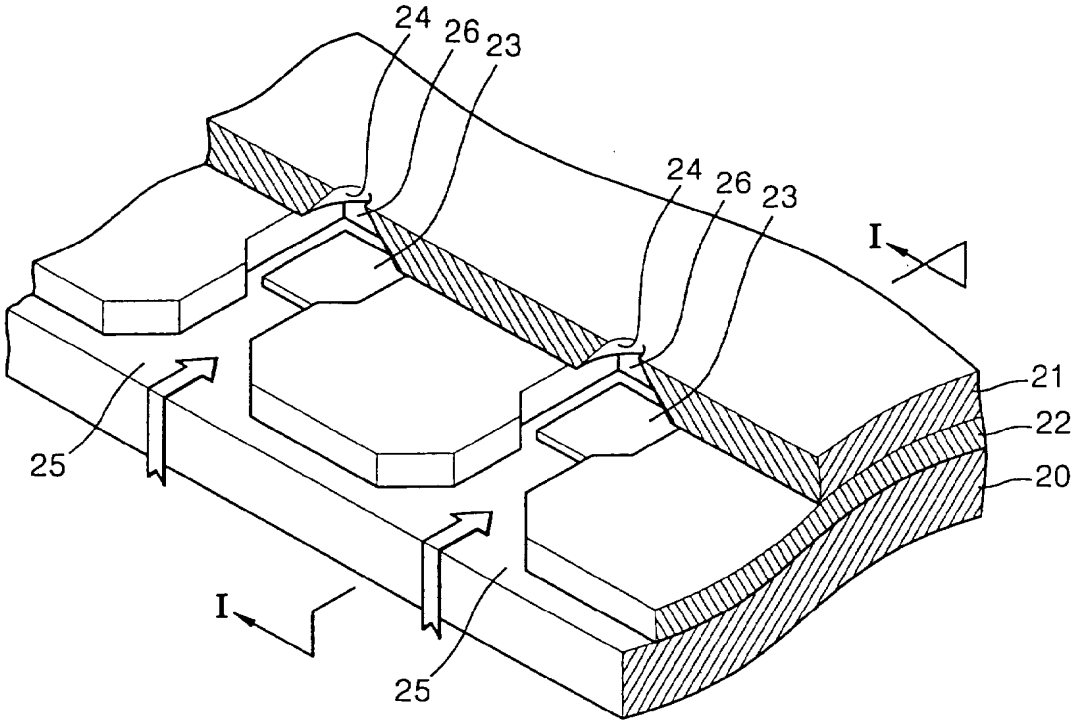

FIG. 3 (PRIOR ART)

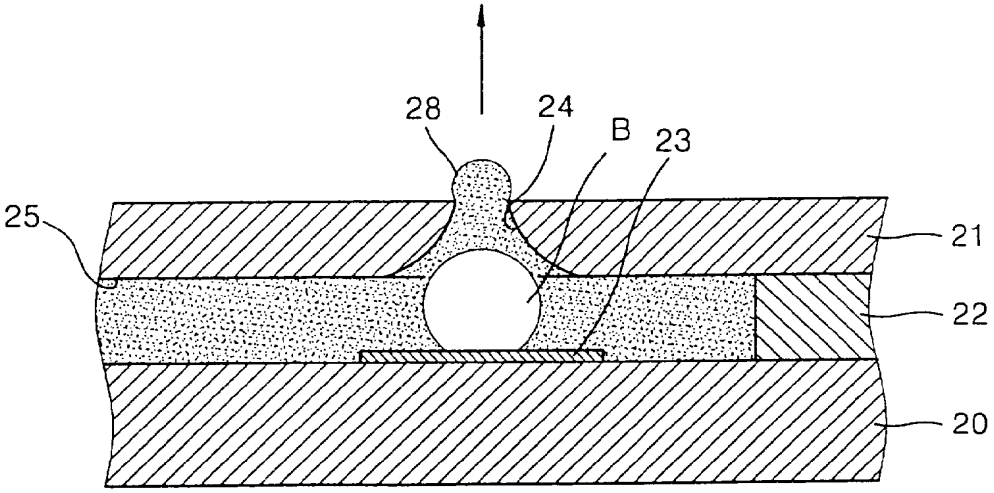

FIG. 4

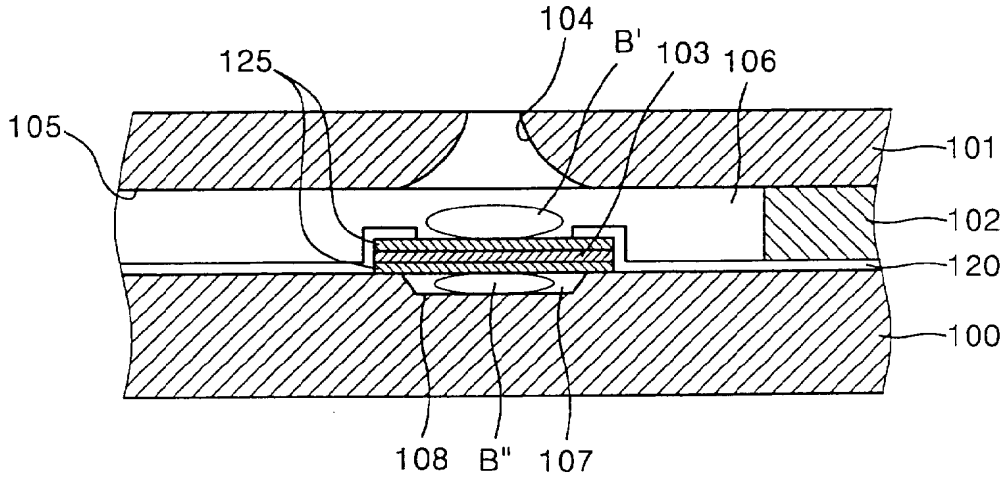
104
B'
103
106
125
105
101
102
120
100
108
B"
107

FIG. 5

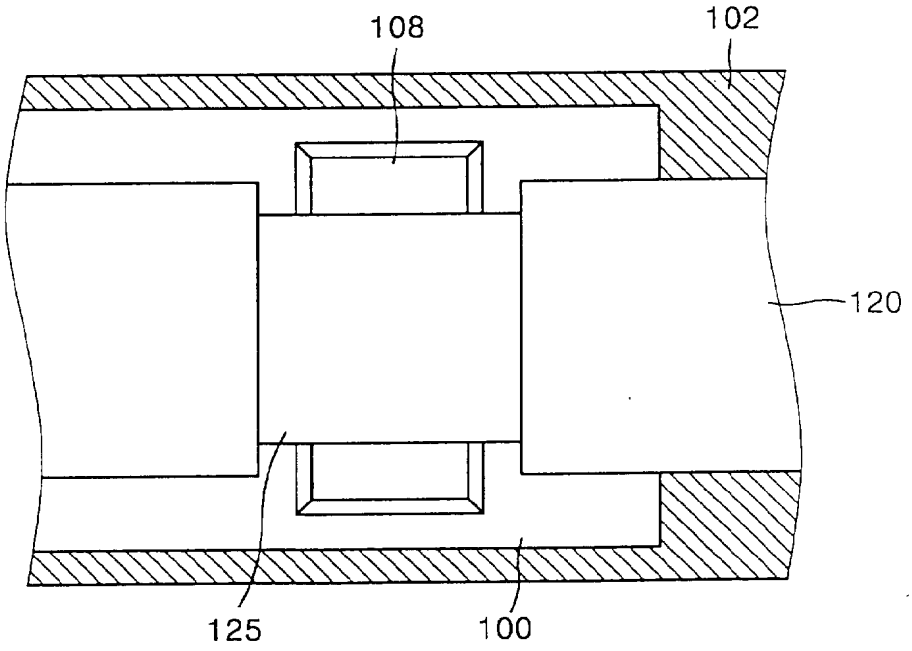
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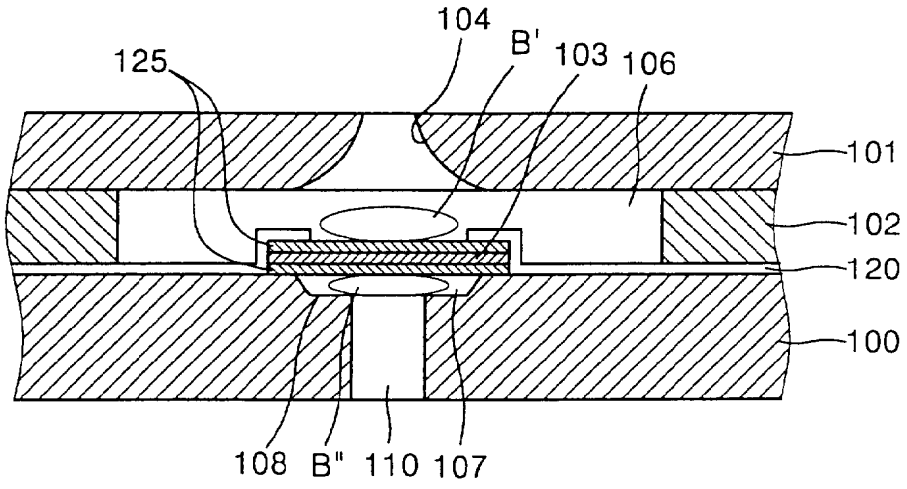
FIG. 6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B'
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B"
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FIG. 7

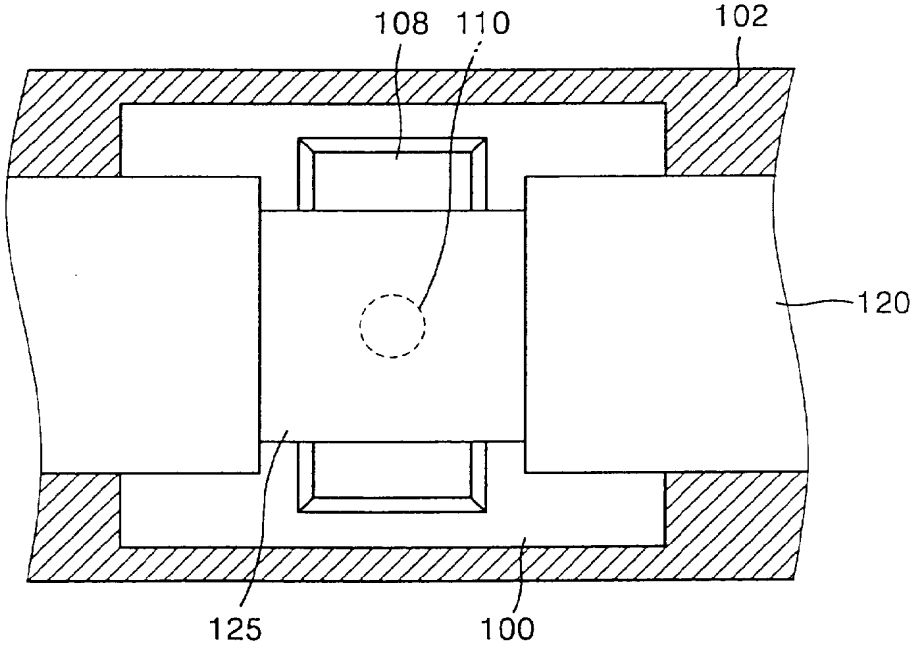
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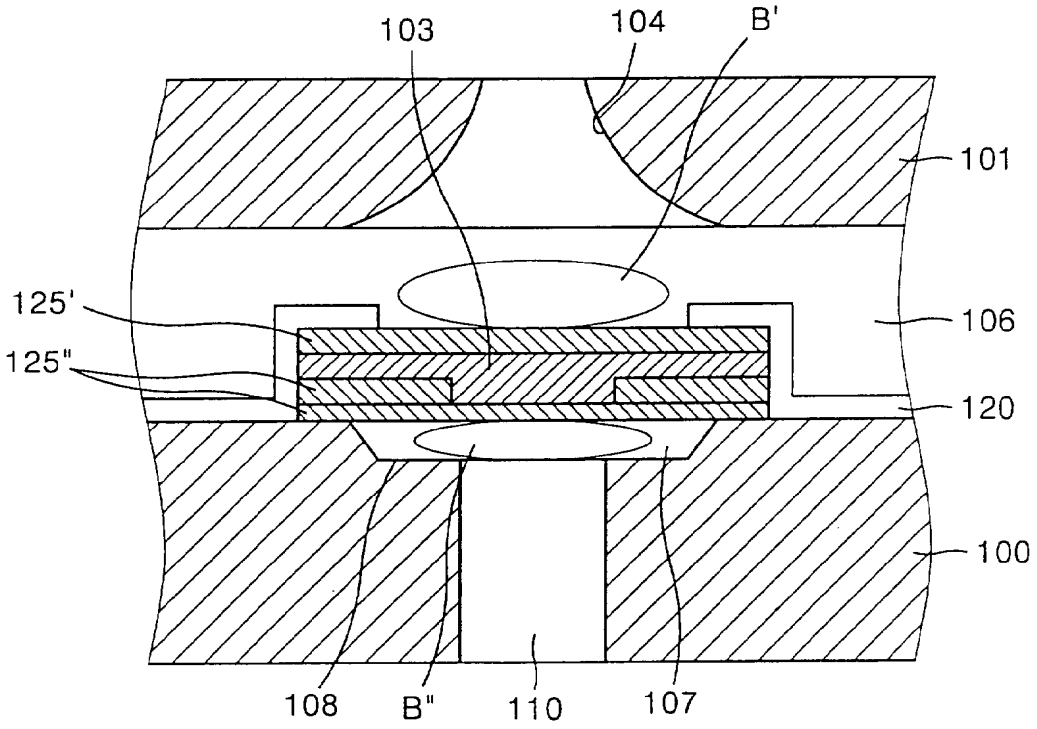
FIG. 8



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EUROPEAN SEARCH REPORT

Application Number
EP 01 30 9836

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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